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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/716,818	11/19/2003	Yi-Lung Cheng	N1085-00141	8692
54657	7590	09/08/2005		
DUANE MORRIS LLP IP DEPARTMENT (TSMC) 4200 ONE LIBERTY PLACE PHILADELPHIA, PA 19103-7396			EXAMINER BOOTH, RICHARD A	
			ART UNIT	PAPER NUMBER
			2812	
DATE MAILED: 09/08/2005				

Please find below and/or attached an Office communication concerning this application or proceeding.

<b>Office Action Summary</b>	<b>Application No.</b> 10/716,818	<b>Applicant(s)</b> CHENG ET AL.	
	<b>Examiner</b> Richard A. Booth	<b>Art Unit</b> 2812	

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --**  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

#### Status

- 1) ☒ Responsive to communication(s) filed on 28 June 2005.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

#### Disposition of Claims

- 4) ☒ Claim(s) 1-26 is/are pending in the application.
- 4a) Of the above claim(s) 14-23 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-13 and 24-26 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

#### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

#### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \*    c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

#### Attachment(s)

- |   |   |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)   | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)  | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date <u>0705</u> . | 6) <input type="checkbox"/> Other: _____  |

## **DETAILED ACTION**

### ***Election/Restrictions***

Applicant's election with traverse of group I in the reply filed on 06/28/05 is acknowledged. The traversal is on the ground(s) that the reason given for how the product can be made by a materially different process is not valid. This is not found persuasive because the reason given is a suitable alternative since an opening would not need to be formed in the layer itself.

The requirement is still deemed proper and is therefore made FINAL.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 1-2, 6-8, 10-11, and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sundararajan et al., U.S. Patent 6,444,568 in view of Zhao et al., US 2004/0203176.

Sundararajan et al. shows the invention substantially as claimed including a method for reducing metal diffusion in a semiconductor device, comprising: forming a copper containing metal portion 110 over a substrate; forming a silicon carbon nitride diffusion prevention layer 115 on the copper containing metal portion; depositing a first dielectric layer 120A over the SiCN layer; and generating an opening in the SiCN layer and the first dielectric layer for a connection metal portion 145 to be connected to the copper containing metal portion, wherein the SiCN layer reduces the diffusion of the copper containing metal portion into the first dielectric layer (see figs. 1A-1B and col. 3-line 58 to col. 6-line 20).

Sundararajan et al. does not expressly disclose where the SiCN layer is a SiCNO layer.

Zhao et al. discloses forming a SiCNO layer either as a thin dielectric layer between each of the interlevel dielectric layers or as the interlevel dielectric layers themselves (see paragraph 0048). In view of this disclosure, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Sundararajan et al. so as to form the SiCN layer as a SiCNO layer because this is shown by Zhao et al. to be a suitable dielectric layer to be used in metallization structures.

With respect to claim 2, note that the diffusion prevention layer in Sundararajan et al. can be performed in a PECVD chamber (see col. 5-lines 4-6).

With respect to claim 6, note that the diffusion prevention layer in Sundararajan can be formed in a HDP deposition chamber (see col. 2-line 65 and col. 3-line 1).

Regarding claim 7, note that Sundararajan further discloses that the generating further includes: etching the first dielectric layer 120A and the diffusion prevention layer 115 to form a trench region and a via region; and depositing the connection material portion 145 into the trench and via regions (see col. 4-lines 9-19).

Moreover, concerning claim 8, note that Sundararajan also discloses where the method further includes forming a sealing diffusion prevention layer 125 on top of the deposited connection metal portion and the first dielectric layer.

With respect to claims 10-11, the neither Sundararajan or Zhao et al. expressly disclose reducing the first dielectric layer to a predetermined thickness and depositing a SiCNO based etch stop layer on top of the reduced first dielectric layer. However, it would have been obvious to one of ordinary skill in the art at the time the invention was made to reduce the first dielectric layer to a predetermined thickness and depositing the SiCNO based etch stop layer on top of the reduced first dielectric layer because planarization processes are commonly done to interlevel dielectrics in metallization structures which would create the reduced first dielectric layer thickness.

Regarding claim 13, Sundararajan further discloses depositing on top of the connecting metal portion a sealing diffusion prevention layer (115 or 125) that seals the connection metal portion and the second dielectric layer thereunder.

Claims 9 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sundararajan et al., U.S. Patent 6,444,568 in view of Zhao et al., US 2004/0203176 as applied to claims 1-2, 6-8, 10-11, and 13 above, and further in view of Wu et al., US 2004/0130035.

Sundararajan et al. and Zhao et al. are applied as above but do not expressly disclose forming a sidewall diffusion prevention layer on the sidewalls of the via and trench.

Wu et al. discloses forming a sidewall diffusion prevention layer 110 on the sidewalls of the via and trench (see fig. 5 and paragraph 0025). In view of this disclosure, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Sundararajan et al. modified by Zhao et al. so as to form the diffusion prevention layer on the sidewalls of the via and trench because such a layer will prevent diffusion of the copper into the interlevel dielectric layer.

Claims 3-5 and 24-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sundararajan et al., U.S. Patent 6,444,568 in view of Zhao et al., US 2004/0203176 as applied to claims 1-2, 6-8, 10-11, and 13 above, and further in view of Zheng et al., U.S. Patent 6,551,893 or Huang et al., US 2002/0016085

Sundararajan et al. and Zhao et al. are applied as above but do not expressly disclose forming the SiCNO layer by depositing a silicon precursor layer and exposing the precursor layer to gases including carbon, nitrogen, and oxygen.

Zheng et al. discloses depositing a silicon precursor and then reacting the silicon precursor with a nitrogen containing gas to form a silicon nitride layer (see col. 2-lines 56-63). Alternatively, Huang et al. discloses exposing a silicon containing layer to a nitrogen gas in order to nitride the layer (see paragraphs 0051-0057). In view of these disclosures, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Sundararajan et al. modified by Zhao so as to form the diffusion prevention layer by depositing a silicon precursor layer and exposing the precursor layer to carbon, nitrogen, and oxygen gases because both Zheng et al. and Huang teach the suitability of depositing a layer and exposing the layer to gases, for example, nitrogen, to alter the composition of the layer.

Regarding the particular gases of claim 4, the examiner takes official notice that the particular selection of gases are notoriously well known in the art for being a precursor gas which is beneficial in forming carbon, nitrogen, and oxygen based layers.

With respect to the temperature and pressure of the process, it would have been obvious to one of ordinary skill in the art at the time the invention was made to determine through routine experimentation the optimum temperature and pressure of the process based upon a variety of factors including, for example, the desired deposition rate and such limitation would not lend patentability to the instant application absent a showing of unexpected results.

Claim 26 is rejected under 35 U.S.C. 103(a) as being unpatentable over Sundararajan et al., U.S. Patent 6,444,568 in view of Zhao et al., US 2004/0203176 and further in view of Zheng et al., U.S. Patent 6,551,893 or Huang et al., US 2002/0016085 as applied to claims 3-5 and 24-25 above, and further in view of Wu et al., US 2004/0130035.

Sundararajan et al., Zhao et al., Zheng et al., and Huang are applied as above but do not expressly disclose forming a sidewall diffusion prevention layer on the sidewalls of the via and trench.

Wu et al. discloses forming a sidewall diffusion prevention layer 110 on the sidewalls of the via and trench (see fig. 5 and paragraph 0025). In view of this disclosure, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the process of Sundararajan et al. modified by Zhao et al., Zheng et al. and Huang et al. so as to form the diffusion prevention layer on the sidewalls of the via and trench because such a layer will prevent diffusion of the copper into the interlevel dielectric layer.

### ***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Richard A. Booth whose telephone number is (571) 272-1668. The examiner can normally be reached on Monday-Thursday from 7:30-6:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Lebentritt can be reached on (571) 272-1873. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Richard A. Booth  
Primary Examiner  
Art Unit 2812

September 2, 2005